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DIVERSITY, POPULATION AND MICROHABITAT USED BY SPIDERS IN CITRUS AGROECOSYSTEM

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ABSTRACT

The spider species from citrus agro-ecosystem were identified during 2011-2013. 54 species from 43 genera and seventeen families were recorded. By using visual observation method and pit fall trap method, in all 6975 spider specimens per acre were collected. Thomisids dominated the collection with 1679 (24.07%) specimens followed by Araneids 1366 (19.58%), Lycosids 788 (11.29%) and Salticids 762 (10.92%). Thus species population was in the order of Thomisidae > Araneidae > Lycosidae > Salticidae > Tetragnathidae. The dominant species recorded from Citrus agroecosystem were *Tmarus indoaurantiaca* sp. nov., *Lycosa poonaensis, Eriovixia excelsa, Indoxysticus minutus, Philodamia citrofoliata* sp. nov., *Uloborus walckenaerius* and *Poltys illepidus.* The collection was dominated by the hunters 4320 (61.93%). 2655 web builders were collected consisting of 38.07% of the collection. The information about microhabitat used by the spiders in citrus agro-ecosystem is also provided for each species.
Keywords: Spiders, Citrus fields, agroecosystems,

INTRODUCTION

Citrus is the most important fruit crop of Central India. Purna river basin is the agroecosystem in which cotton and citrus are particularly grown as cash crops.

The diversity of spiders was extensively studied to know the occurrence of various species which are preying on the pest on orange trees. The present study was an attempt to make an inventory of spiders along with the details about the microhabitats used by the spiders.

Spiders play an important role in regulating insect pests in agriculture ecosystems (Nyffeler and Benz, 1987; Nyffeler *et al.*, 1994; Sunderland, 1999). Studies of Hamamura (1969); Sasaba *et al.* (1973); Gavarra and Raros (1973); Samal and Misra (1975); Kobayashi (1977); Chiu (1979); Holt *et al.* (1987) and Tanaka (1989) clearly described the role of spiders as predators in reducing insect pests in rice fields. Muma, 1975; Carroll, 1980; Mansour and Whitcomb (1986);

Van Den Berg *et al.*,1992; Breene *et al.*, 1993; Amalin *et al.* (2001a;b); Ghavami Ghanadamooz (2008) and Tahir, *et al.* (2011) investigated diversity and habitat use by spiders in citrus ecosystem in Florida, California, Israel, South Africa, Texas, Florida, Iran and Pakistan respectively.

Absolutely no work has been carried out to know the spider diversity in Citrus agro-ecosystem from India and hence this is the first attempt.

METHODOLOGY

Study area: The present work was carried out in agricultural fields from Purna river basin. River Purna originates in Pokharni Village 21° 30'N 77° 46'E which is 2 km away from Bhainsdehi. Bhainsdehi is a thasil place in Betul district Madhya Pradesh adjoining Amravati district of Maharashtra. The river Purna (Fig.1) enters in Amravati district and flows through Akola, Buldhana, and Jalgaon districts and empties in Tapi at Hatnur in Jalgaon district. Total length of Purna River is 334 km. Gotma, Aarna, Pendhi, Uma, Katepurna, Shahanur, Bhavkhuri, Chandrabhaga , Bhuleswari, Morna, Mann, Mas, Utawali, Vishwamitri, Nirguna, Gandhari, Aas, Dnyanganga, Vishwaganga, Nalaganga, and Vaan rivers are the tributaries of Purna. The catchment area of all these rivers forms the Purna basin.

Spider collection: Spiders were collected from citrus fields by using pitfall traps, visual observation and by hand collection methods. Sampling was carried out over three periods, winter (November – February), summer (March – June), Rainy season (July – October). The spiders were mostly collected in the morning during 7.30 am to 9.30 am and during night from 7.00 pm to 11.30 pm. Pitfall trap method was used for collecting the ground dwelling spiders. The pitfall traps consisted of a 9 cm wide by 16 cm deep plastic jar. Two hundred and fifty ml of 95% ethylene glycol and 2 drops of soap solution were added to each trap. The pitfall traps were left open for a period of three days. The distance between two adjacent jars was 5 meter. A plastic cover was placed over each trap to prevent direct sunlight and rain. After collection spiders were brought to the laboratory, washed with alcohol and transfer into 70% alcohol for further study. The data collected was then converted into per acre for calculations.

Presevation: After taking the necessary photographs, the legs and palp of the spiders were made straight by dipping them in warm water and after making their legs straight they were immediately transferred to 70% ethyl alcohol in a petridish. Plastic U-pins were kept on spider legs and palp as weight, so that they are not folded back. The petridish with properly oriented spider in it was kept covered for 24 hours, to prevent the evaporation of alcohol. After 24 hours of proper fixation,

then the spiders were stored in glass /plastic bottles of proper size in legs spread condition, properly labeled or taken for further study.

All adult specimens were identified up to species level. Identification of spiders was done on the basis of morphometric characters of various body parts and the detail structures of male and female genital organs. A help of various keys and World Spider Catalogue (recent edition) and other relevant literature from India and abroad was taken for proper identification.

During survey and collection of spiders, the microhabitats used by them were noted and accordingly the detail observations of each spider collected are given. Categorically, three types of major microhabitats were noted, in the web, on the plant/branches and on the ground. Among web builders also, webs were found to be constructed on the ground (epigeal), between ground and plant (basal) and between adjacent plants and branches (foliar). Hunting spiders were seen using microhabitats like mulch and litter on the ground, crevices in the ground, on the ground surface, foliage, on the plants and dried leaves etc.

Spiders captured by pitfall traps, and hand picking methods were pooled for each site for quantitative analysis. Species richness was estimated using the diversity indices including Shannon – weiner index, Simpson index and Margalef richness index. The diversity and richness indices for spiders were calculated using the Biodiversity calculator (www. Alyoung.com/labs/biodiversity calculator. html).

Voucher specimens are deposited at Arachnology Museum, Forest Training Institute, Chikhaldara, Maharashtra-India.

OBSERVATIONS AND RESULTS

54 species from 43 genera and 17 families were recorded during the present investigation (Table-1). By using visual observation method and pit fall trap method, in all 6975 spider specimens were collected per acre which included 3222 (46.19%) females, 1274 (18.26%) males and 2479 (35.54%) immature specimens. Thomisids dominated the collection with 1679 (24.07%) specimens followed by Araneids 1366 (19.58%), Lycosids 788 (11.29%) and Salticids 762 (10.92%). Thus species population was in the order of Thomisidae > Araneidae > Lycosidae > Salticidae > Tetragnathidae. Salticidae exhibited highest generic and species diversity followed by Araneidae and Thomisidae with 6 genera each. The collection was dominated by the hunters 4320 (61.93%). 2655 web builders were collected consisting of 38.06% of the collection. The dominant species recorded from Citrus agroecosystem were *Tmarus indoaurantiaca* sp. nov., *Lycosa poonaensis, Eriovixia excelsa, Indoxysticus minutes, Philodamia citrofoliata* sp. nov., *Uloborus walckenaerius*

Table: 1, Spider species collected (per acre) from Citrus agro-ecosystem.

Spider species	Female	Male	Immature	Total
Family Araneidae Clerck, 1757			333	1366
Argiope aemula (Walckenaer,1841)	54	0		
Cyclosa bifida (Doleschall,1859)	49	0		
Cyclosa moonduensis Tikader,1963	19	14		
Cyclosa spirifera Simon,1889	55	12		
Cyrtophora citricola (Forsskål,1775) *	32	18		
Eriovixia excelsa (Simon,1889)	180	90		
Neoscona nautica (L. Koch,1875)	48	0		
Neoscona theisi (Walckenaer,1841)	219	80		
Neoscona vigilans (Blackwall,1865)	38	20		
Poltys illepidus C. L. Koch,1843 *	105	0		
Family Clubionidae Wagner,1887			32	128
Clubiona foliata sp. nov.	57	39		
Family Eresidae C. L. Koch, 1845			119	232
Stegodyphus sarasinorum Karsch,1891	86	27		
Family Gnaphosidae Pocock,1898			83	257
Drassodes luridus (O. P.-Cambridge,1874)	44	24		
Sergiolus singhi Tikader & Gajbe,1976	11	0		
Zelotes shantae Tikader,1982	72	23		
Family Hersiliidae Thorell,1870			49	129
Hersilia savignyi Lucas,1836	62	18		
Family Lycosidae Sundevall,1833			287	788
Hippasa greenalliae (Blackwall,1867)	47	12		
Lycosa poonaensis Tikader & Malhotra,1980	194	0		

Continued.....

Spider species	Female	Male	Immature	Total
Pardosa oriens (Chamberlin,1924)	48	23		
Pardosa pseudoannulata (Bösenberg & Strand,1906)	96	81		
Family Mimetidae Simon,1881			5	11
Mimetus indicus Simon,1906	4	2		
Family Eutichuridae Lehtinen 1967			36	105
Cheiracanthium inornatum O. P.-Cambridge,1874	51	18		
Family Oxyopidae Thorell,1870			36	193
Oxyopes pankaji Gajbe & Gajbe,2000	40	19		
Oxyopes tiengianensis Barrion & Litsinger,1995	63	21		
Peucetia latikae Tikader,1970	0	14		
Family Pholcidae C. L. Koch,1850			19	62
Crossopriza lyoni (Blackwall,1867)	30	13		
Family Salticidae Blackwall,1841			251	762
Hasarius adansoni (Audouin,1826) *	20	57		
Hyllus semicupreus (Simon,1885)	0	46		
Menemerus bivittatus (Dufour, 1831)	44	25		
Myrmarachne plataleoides (O. P.-Cambridge,1869)	0	2		
Myrmarachne sp.nov.	12	3		
Phintella vittata (C. L. Koch,1846)	41	22		
Plexippus paykulli (Audouin,1826) *	52	47		
Rhene flavigera (C. L. Koch,1846) *	0	21		
Telamonia dimidiata (Simon,1899)	58	10		

Continued.....

Spider species	Female	Male	Immature	Total
Thyene imperialis (Rossi,1846) *	35	16		
Family Scytodidae Blackwall,1864			19	81
Scytodes sp.nov.	62	0		
Family Sparassidae Bertkau,1872			163	187
Heteropoda bhaikakai Patel & Patel,1973	7	2		
*Olios mille**ti*** (Pocock,1901)	0	0		
Olios obesulus (Pocock,1901)	2	13		
Family Tetragnathidae Menge,1866			163	415
Guizygiella indica (Tikader & Bal,1980)	127	73		
Leucauge decorata (Blackwall,1864)	36	16		
Family Theridiidae Sundevall,1833			74	202
Parasteatoda mundula (L. Koch,1872)	98	0		
Nesticodes rufipes (Lucas,1846) *	21	9		
Family Thomisidae Sundevall,1833			625	1679
Indoxysticus minutus (Tikader, 1960) *	172	98		
Massuria herba sp. nov.	90	0		
Ozyptila biprominula Tang & Li, 2010	0	124		
Philodamia citrofoliata sp. nov.	125	31		
Thomisus okinawensis Strand,1907	64	0		
Thomisus perspicillatus (Thorell,1890)	11	0		
Thomisus sp. nov.	49	13		
Thomisus sp. nov.	37	0		
Tmarus indoaurantiaca sp. nov.	240	0		
Family Uloboridae Thorell,1869			185	378
Uloborus walckenaerius Latreille,1806 *	115	78		
17 FAMILIES, 43 GENERA, 54 SPECIES	3222	1274	2479	6975

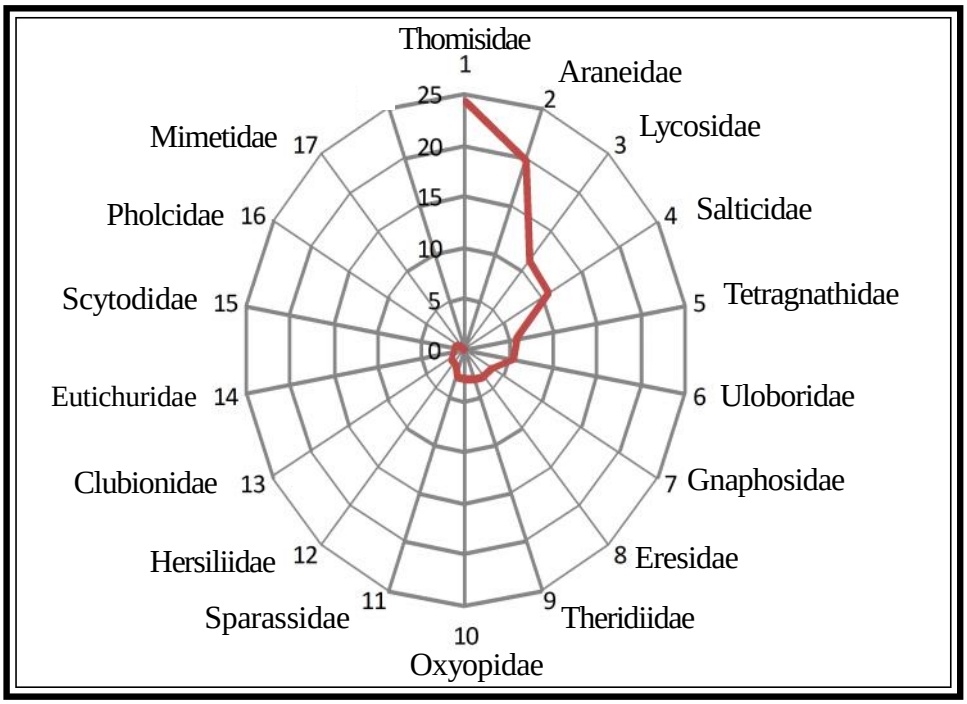

Fig. 1, Familywise percent occurrence of spider population per acre of Citrus agro-ecosystem

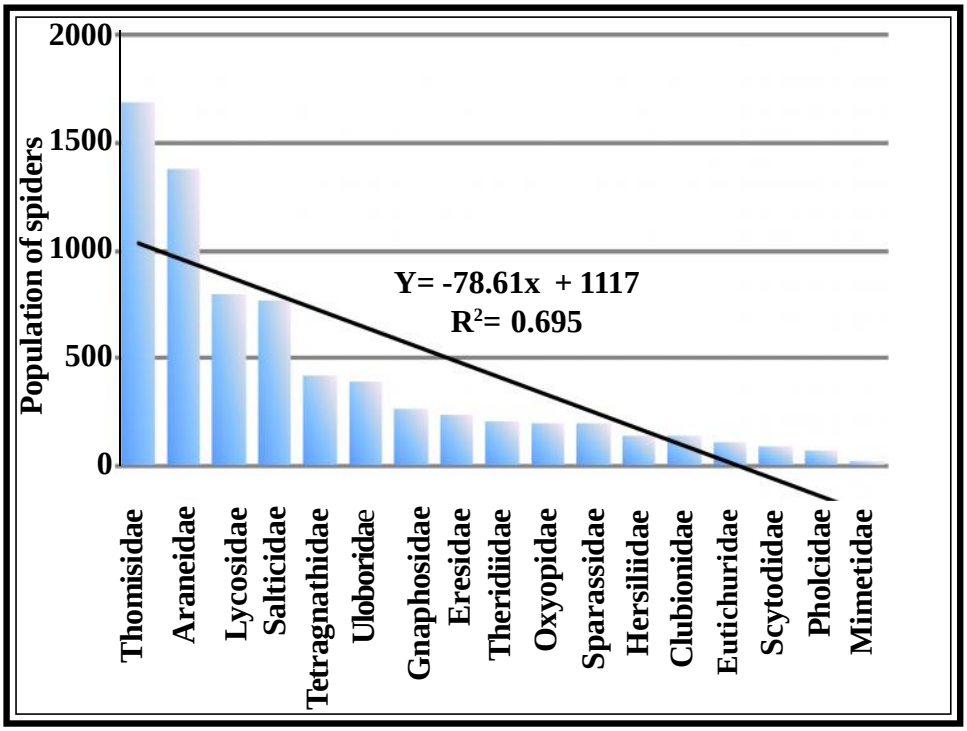

Fig. 2, Trendline and Coefficient of Determination (R^2) for the occurrence of spiders in the citrus agro-ecosystem from Purna river basisn.

Table: 2, Microhabitat used by spiders in citrus agro-ecosystem

Species	Microhabitat used by spiders in Citrus field
Argiope aemula (Walckenaer,1841)	In sunny areas resting on web near the ground, in grasses
Cyclosa bifida (Doleschall,1859)	On the web nearer to the ground
Cyclosa moonduensis Tikader,1963	On the web nearer to the ground
Cyclosa spirifera Simon,1889	On the web between adjacent branches
Cyrtophora citricola (Forsskål,1775)*	In the web nearer to the ground surface
Eriovixia excelsa (Simon,1889)	Between trees and tree branches
Neoscona nautica (L. Koch,1875)	In grasses, on webs between branches, inside folded leaves
Neoscona theisi (Walckenaer,1841)	In grasses, on webs between branches of adjacent trees, inside folded leaves
Neoscona vigilans (Blackwall,1865)	In grasses, on webs between branches of adjacent trees, inside folded leaves
Poltys illepidus C. L. Koch,1843 *	On the web between trees, on branches
Clubiona foliata sp. nov.	Inside silken brood chamber in curled leaves, on foliage, under loose tree bark, folded blade of grass
Stegodyphus sarasinorum Karsch,1891	Inside the web on the tip of the branches
Drassodes luridus (O. P.-Cambridge,1874)	On the ground, in leaf litter
Sergiolus singhi Tikader & Gajbe,1976	On the ground, in leaf litter
Zelotes shantae Tikader,1982	On the ground, in leaf litter
Hersilia savignyi Lucas,1836	On trunk
Hippasa greenalliae (Blackwall,1867)	At the base of trunk in funnel web
Lycosa poonaensis Tikader & Malhotra,1980	Ground, leaf litter, in grasses
Pardosa oriens (Chamberlin,1924)	Ground, leaf litter, in grasses
Pardosa pseudoannulata (Bösenberg & Strand,1906)	Ground, leaf litter, in grasses

Continued.....

Species	Microhabitat used by spiders in Citrus field
Mimetus indicus Simon,1906	Underside of the leaves, at the base of trunk
Cheiracanthium inornatum O. P.-Cambridge,1874	On foliage, leaf litter
Oxyopes pankaji Gajbe & Gajbe,2000	On foliage, on ground
Oxyopes tiengianensis Barrion & Litsinger,1995	On foliage, on ground
Peucetia latikae Tikader,1970	On foliage, in grasses
Crossopriza lyoni (Blackwall,1867)	Inside the crevices in tree trunk or in loose bark
Hasarius adansoni (Audouin,1826) *	Ground, foliage, leaf litter, under loose bark, in grasses
Hyllus semicupreus (Simon,1885)	Ground, foliage, leaf litter, under loose bark, in grasses
Menemerus bivittatus (Dufour, 1831)	On tree trunk
Myrmarachne plataleoides (O. P.-Cambridge,1869)	On tree trunk
Myrmarachne sp.	On trunk, branches and ground
Phintella vittata (C. L. Koch,1846)	Throughout the tree and leaf litter
Plexippus paykulli (Audouin,1826) *	Throughout the tree, leaf litter and ground
Rhene flavigera (C. L. Koch,1846) *	Throughout the tree, leaf litter and ground
Telamonia dimidiata (Simon,1899)	Throughout the tree
Thyene imperialis (Rossi,1846) *	Throughout the tree
Scytodes sp.	On the ground
Heteropoda bhaikakai Patel & Patel,1973	Ground, leaf litter
Olios milleti (Pocock,1901)	On foliage
Olios obesulus (Pocock,1901)	On foliage
Guizygiella indica (Tikader & Bal,1980)	Throughout the tree
Leucauge decorata (Blackwall,1864)	In grasses, near the ground surface
Parasteatoda mundula (L. Koch,1872)	Inside the dried leaf upside down entangled in the web
Nesticodes rufipes (Lucas,1846) *	In the web
Indoxysticus minutes (Tikader, 1960) *	On foliage
Massuria herba sp.nov.	Inside the folded blade of grasses

Continued.....

Species	Microhabitat used by spiders in Citrus field
Ozyptila biprominula Tang & Li, 2010	On foliage, on flowers
Philodamia citrofoliata sp. nov.	On foliage, on flowers
Thomisus okinawensis Strand,1907	On foliage, on flowers
Thomisus perspicillatus (Thorell,1890)	On foliage, on flowers
Thomisus sp. nov.	On foliage, on flowers
Thomisus sp. nov.	On foliage, on flowers
Tmarus indoaurantiaca sp. nov.	In grasses, throughout the tree
Uloborus walckenaerius Latreille,1806 *	Beaneath the leaves

and *Poltys illepidus. Poltys illepidus* were diurnal in feeding habitat and were exclusively reported only from Citrus agroecosystem.

DISCUSSION

The orb weaver, *Poltys illepidus* were observed in Citrus agro-ecosystem which were seen constructing very fine but big orb webs in between adjacent Citrus plants during evening. During day time, *Poltys* were seen resting on tree trunks/ branches to which they are perfectly camouflaged. This spider is reported for the first time from India. Another important observation from Citrus agro-ecosystem is species diversity and numerical dominance of Thomisids. 9 species and more than 24% population of Thomisid spiders indicates highest diversity and dominance respectively. The dominance index (1- Simpson index) calculated for Citrus agro-ecosystem is 0.9365 which indicates greater diversity and the Shannon index (5.286) indicates more diverse communities. Oxyopid and Sparassid spiders were found in less number in Citrus agro-ecosystem at the same time this agro-ecosystem was rich in Thomisid and Araneid spiders.

In Citrus agro-ecosystem Thomisids and Araneids like *Poltys* and *Neoscona* can be advocated for rearing to achieve pest control.

The dominance index (1-Simpson index) calculated for Citrus agro-ecosystem was 0.9365 and the Shannon index as 5.286. Margalef richness index is (6.301) for spider diversity in Citrus agro-ecosystem. The R-squared value calculated for Citrus agro-ecosystem is 0.695.

REFERENCES

Amalin, D. M.; Pena, J. E.; Mcsorley, R.; Browning, H. W. and Crane, J. H. 2001a. Comparision of different sampling methods and effect of pesticide application on spider population in lime orchards in south Florida. *Environ. Ent.*, **30:** 1021-1027.

Amalin, D. M.; Reiskind, J.; Pena, J. E. and Mcsorley, R. 2001b. Predatory behavior of three species of sac spiders attacking citrus leafminer. *Journal of Arachnology*. **29:**72-81.

Breene, R. G.; Dean, D. A.; Nyffeler, M. and Edwards, G. B. 1993. Biology, predation ecology and significance of spiders in Texas cotton ecosystems with a key to the species. Bulletin Texas A&M Experiment station 1711, 115p.

Carroll, D. P. 1980. Biological notes on the spiders of some citrus groves in central and southern California. *Entomol. News*. **91:** 147-154.

Chu, Y. I. and Okuma, C. 1970. Preliminary survey on the spider-fauna of the paddy fields in Taiwan. *Mushi.*, **44:** 65-88.

Gavarra, M. and Raros, R. S. 1973. Studies on the biology of predator wolf spider, *Lycosa pseudoannulata* Bos. et Str. (Araneae: Lycosidae). *Philippine Entomologist*. **2(6):** 427.

Ghavami, S. and Ghanadamooz, S. 2008. Investigation of spider (order Araneae) fauna of citrus orchards in the Northern part of Iran. *J. Applied Biol. Sci.*, **2(1):** 73-76.

Hamamura, T. 1969. Seasonal fluctuation of spider populations in paddy fields. *Acta Arachnologia*. **22:** 240-50.

Holt, J.; Cook, A. J.; Perfect, T. J. and Norton, G. A. 1987. Simulation analysis of brown plant hopper (*Nilaparvata lugens*) population dynamics on rice in the Philippines. *Journal of Applied Ecology*. **24:** 87-102.

Kobayashi, S. 1977. Changes in population density of the spiders in paddy fields during winter. *Acta Arachnologia*. **27:** 247-251.

Mansour, F. and Whitcomb, W. H. 1986. The spiders of a citrus grove in Israel and their role as biocontrol agents of *Ceroplastes floridensis* (Homoptera: Coccidae). *Entomophaga*. **31:** 269-276.

Muma, M. H. 1975. Spiders in florida citrus groves. Florida Citrus groves. *Florida Entomologist*. **58:** 83-90.

Nyffeler, M. and Benz, G. 1987. Spiders in natural pest control: a review. *Journal of Applied Entomology.* **103:** 321-339.

Nyffeler, M.; Sterling, W. L. and Dean, D. A. 1994. Insectivorous activities of spiders in United States field crops. *Journal of Applied Entomology.* **118:** 113-128.

Samal, P. and Misra, F. B. C. 1975. Spiders: the most effective natural enemies of the brown plant hoppers in rice. *Rice Entomology Newsletter*. **3:** 31.

Sasaba, T.; Kiritani, K. and Kawahara, S. 1973. Food preference of *Lycosa* in paddy fields. *Bulletin of the Kochi Institute of Agriculture and Forestry Science*. **5:** 61-63.

Sunderland, K. 1999. Mechanisms underlying the effects of spiders on pest populations. *Journal of Arachnology*. **27:** 308-316.

Tahir, H.M.; Butt, A.; Naheed, R.; Bilal, M. and Alam, I. 2011. Activity density of spiders inhabiting the citrus field in Lahore, Pakistan. *Pakistan J. Zool.*, **43(4):** 683-688.

Tanaka, K. 1989. Movement of spiders in arable land. *Plant Protection*. **43(1):** 34-39.